SYSTEM AND METHOD FOR DETERMINING RECEIVED PILOT POWER AND PATH LOSS IN A CDMA COMMUNICATION SYSTEM

BACKGROUND OF THE INVENTION

I. Field of the Invention

The present invention relates to communication systems. More particularly, the present invention relates to an improved system and method for determining, in a code division multiple access (CDMA) communication system, the power of a received pilot signal received by a remote site station and for using this value to more accurately estimate path loss between the remote site station and a base station.

II. Description of the Related Art

In a CDMA cellular telephone system, such as that described in Telecommunications Industry Association (TIA)/Electronic Industries Association (EIA) Interim Standard 95 (IS-95) entitled "Mobile Station-Base Station Compatibility Standard for Dual-Mode Wideband Spread Spectrum Cellular System," a common frequency band is used for communication with all base stations in a system. The common frequency band allows simultaneously communication between a mobile station and more than one base station. Signals occupying the common frequency band are discriminated at the receiving station through the spread spectrum CDMA waveform properties based on the use of a high speed pseudonoise (PN) code. The high speed PN code is used to modulate signals transmitted from the base stations and the mobile stations. Transmitter stations using different PN codes or PN codes that are offset in time produce signals that can be separately received at the receiving station. The high speed PN modulation also allows the receiving station to receive a signal from a single transmitting station where the signal has traveled over several distinct propagation paths.

The path loss in the CDMA mobile radio channel can be characterized by two separate phenomena: average path loss and fading. The forward link, from the base station to the mobile station, operates on a different frequency than the reverse link, which is directed from the mobile station to the base station. However, because the forward link and reverse link frequencies are within the same frequency band, a significant correlation between the average path loss of the two links exists. On the other hand, fading is an independent phenomenon for the forward link and reverse link and varies as a function of time.

In an exemplary CDMA system, each mobile station estimates the total received power of desired CDMA signals on the assigned CDMA frequency channel of the forward link based on the total received power of all signals in the CDMA bandwidth at the input to the mobile station. The total received power is comprised of the sum of the power of a desired CDMA signal received from the base station presently assigned to the mobile station, and the power of various interfering signals that fall within the CDMA bandwidth. Such interfering signals may be received from other CDMA base stations operating on the frequency assigned to the mobile station, as well as from other nearby communication systems. Since the path loss on the forward and reverse links are assumed to be closely correlated, the mobile station uses the estimate of the forward link power to set the transmit level of the reverse link signal. The transmit level of the reverse link signal is adjusted in order to match the estimated path loss on the reverse link, and arrive at the base station at a predetermined level. Such an open-loop power control system is described in U.S. Pat. No. 5,056,109 entitled "METHOD AND APPARATUS FOR CONTROLLING TRANSMISSION POWER IN A CDMA CELLULAR MOBILE TELEPHONE SYSTEM", assigned to the assignee of the present invention and incorporated herein by reference.

The mobile station may also provide an indication of channel quality to its user based on the estimated path loss. When the estimated path loss is high, the user may be informed through a display or the like that adverse channel quality may be experienced if it were attempted to initiate communication. Conversely, an indication of acceptable channel quality may be provided when the estimated path loss is below a predefined threshold. Such indications of channel quality assist the user in determining whether communication with the base station may be sustained. For example, a typical mobile station may have a visual display of a number of "signal level bars" that indicate the relative strength of the received energy on the forward link from the cell-site to the mobile station, and therefore the estimated path loss of the reverse link from the mobile station to the cell-site.

Additionally, the mobile station uses the estimated path loss in determining the power level it should transmit access probes in order to establish communications with the base station on the access channel. The access channel provides communications from the mobile station to the base station when the mobile station is not using a traffic channel (i.e. when a call is not already in progress). Access channel messages provide for call originations, responses to pages, orders, and registrations. Since the access channel in a typical CDMA communication system is a random access channel, multiple mobile stations may simultaneously try to use the access channel. Although the mobile station randomly chooses a PN time alignment to minimize collisions with other mobile stations that are simultaneously transmitting on the access channel, each additional mobile station transmitting on the access channel contributes to the background noise on the channel, which has a finite capacity.

Unfortunately, the presence of interfering signals within the total power received by the mobile station tends to significantly reduce the accuracy of the mobile station's estimate of path loss. When such an inappropriately reduced estimate of path loss is used to set the open-loop transmit level of the reverse link signal, the level may be lowered below that necessary to ensure the reverse link signal is received with adequate strength at the base station. Similarly, when an inappropriately reduced estimate of path loss results in an overly favorable indication of channel quality being provided to a user, the user may be unsuccessful at initiating communication over the degraded channel. This may lead to user frustration, since the user would expect that it should be possible to establish communication when informed of the existence of favorable channel conditions. Additionally, the inaccurate estimate of path loss would lead to the mobile station sending out initially weaker access probes, resulting in multiple unsuccessful attempts to establish communication on the access channel, and therefore unnecessarily wasting some of the access channel capacity and having an adverse effect on the balance of system loading.

Another way in which the total received power at the mobile station is used is when a network planner is mapping a proposed service area in order to determine coverage. In a conventional mapping method, the total received power at the mobile station (including unwanted interference) is logged and then post-processed to generate contour maps